PROMOTION OF GREEN RECYCLING

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ABSTRACT

In NEXCO East Japan, the amount of mowed grass, pruned branches, and the like generated through the maintenance of the expressway exceeds 110,000 m^3 every year, and some 93% of the amount is recycled in response to the recent increase in environmental awareness.

In the Kanto Branch Office, the amount of phytogenic material generated by the maintenance of the expressways reaches 50,000 m^3, and some 98% of the amount is used to make compost and chips at four greening materials plants.

These compost and chips are used as soil conditioner for trees in expressways under construction, vegetation base material for the afforestation of slopes, and means to prevent weeds from growing in planted areas.

The company aims for the formation of the circulatory system based on the theme “What is caused from the road returns to the road and contributes to the nature growth,” and needs to return to the intended purpose of recycling phytogenic material generated from the maintenance of the green belt, instead of discarding it through incineration.

1. INTRODUCTION

Japan Highway Public Corporation (JH) was split into three companies and privatized in October 2007, and East Nippon Expressway Company Limited (hereinafter referred to as NEXCO East Japan) is one of the stock companies established upon the privatization. NEXCO East Japan conducts construction and management of expressways, service areas, and expressway-related operations in the area of eastern Japan (Fig. 1).

The NEXCO East Japan’s expressways extend about 3,500 km, which are used by some 2,400,000 customers every day. In addition to the maintenance of the expressways with utmost care, so that customers can always use their expressways safely, comfortably, and conveniently. Further, the company is currently proceeding with building a 380-kilometer-long highway network that will contribute

to the development and life of the local areas, including ring roads in the Tokyo metropolitan area.

NEXCO East Japan has the management philosophy that “the company maximizes the effects of the expressways to improve the development and life of the local community and thus to contribute to the revitalization of Japan’s overall economy.” NEXCO East Japan strives to be a company that puts customers first, makes efforts to provide high quality services as professionals in the expressway business. Particularly, the company is actively tackling environmental issues, such as prevention of global warming, contribution to the formation of recycling-based society, and reduction of environmental burdens.

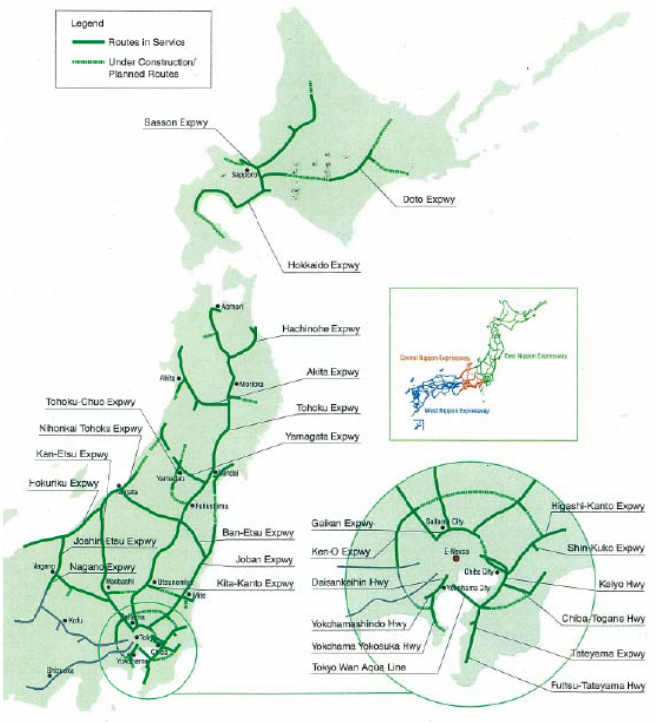

Figure 1. Operation Area of NEXCO East Japan

2. BACKGROUND OF GREEN RECYCLING

In 1992, many countries signed the United Nations Framework Convention on Climate Change to make a full effort on countermeasures against global warming at the Earth Summit held in Rio de Janeiro. Also, the Kyoto Protocol was adopted at the Third Conference of the Parties (COP3) to the UN Framework Convention on Climate Change held in Kyoto in December 1997, so that the countries around the world can accelerate the effort on the countermeasures against global warming in a coordinated manner. The protocol requires Japan to make specific efforts to reduce its total amount of greenhouse gas emissions by 6% compared to the year 1990 no later than 2008 to 2012.

Since these international agreements, social situations relating to environment conservation have greatly changed and improved throughout the world. Today, environmental consciousness is indispensable not only in the construction industry but also in all the other industries. Formulating a recycling-based society is one of the approaches to the environment conservation, and recycling is very important to effectively utilize natural resources, reduce waste, and reduce burden on the society.

3. PURPOSE OF GREEN RECYCLING

Plants are planted at areas such as expressway slopes, interchanges, and parking areas to various functions (Fig. 2). The maintenance work for the green belt on the road slopes and the grass fields in the planted area includes cutting trees and grass as well as pruning branches and leaves. Since the Japanese climate is warm and humid, herbaceous plants grow rapidly in the summer months.

However, the above-ground parts of these plants die in the winter months. Thus, grass needs to be properly cut to prevent fires and maintain the landscape and the surrounding environment. In the past, most of the materials had been discarded through ground burial or incineration.

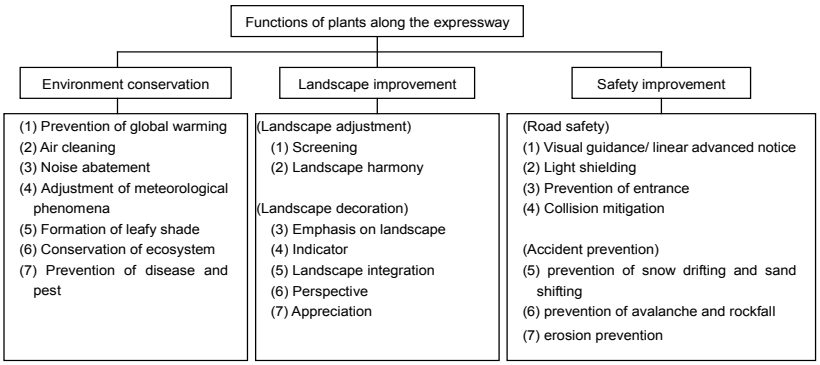

Figure 2. Functions of plants along the expressway

Afterward, the Waste Disposal and Public Cleaning Law came into effect in 1970, and the disposal of phytogenic material through open burning or field heaping was prohibited. In 1991, the Law was revised to state that businesses (including public sectors) must dispose of waste material that they produce on their own responsibility. Thermal disposal directly causes emissions of carbon dioxide, which is known as one of the greenhouse gases, and in addition, the disposal cost is increasing every year. Further, the processable amount at the final disposal site is beginning to reach its limit, and thus, socially and economically, there is an urgent need to effectively utilize phytogenic material and reduce the amount of phytogenic material.

Under such circumstances, NEXCO East Japan started “Green Recycling” in 1994 and the company has been producing compost and chips from phytogenic material generated in its expressway business and returning them to its road business. The purpose of the project is to establish a material circulatory system within the expressway business and contribute to the environment conservation through recycling.

4. OVERVIEW OF GREEN RECYCLING

Fig. 3 shows the basic concept of green recycling used in the road business. Green recycling system to establish an organic resource circulatory system in which the phytogenic material (organic resource) generated in the expressway business is returned to the expressway business. The recycling system must not be simply limited to the recycling of phytogenic material; it is important to organize a series of systems, including planned utilization of all the aspects of the systems. Namely, the systems need to be efficiently operated at all stages, taking into account recycle processing techniques suitable for the characteristics or form of phytogenic material, the size of manufacturing facilities, appropriate quality as recycled material, and steady demand for phytogenic material. It is important to establish a closed system, which is the basis of recycling; that is, resources generated from the expressway must not be released to the outside but returned to the expressway.

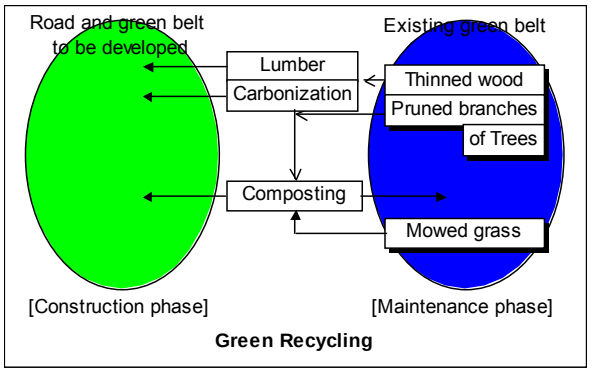

Figure 3. Basic concept of green recycling

NEXCO East Japan is proceeding with afforestation as a straightforward approach to tackle the global warming, utilizing plants' function of absorbing and fixating carbon dioxide known as a greenhouse gas. As of the end of 2007, the planted area reached about 3,400 ha (approximately 98% of the entire embankment slope on which planting is possible), and the carbon dioxide absorption and fixation effects by this planted area are estimated to some 36,000 ton per year. In addition to that, since growth of trees is facilitated by using green material such as compost produced by green recycling, the absorption and fixation of carbon dioxide is effectively accelerated. Thus, it is thought that green recycling is not merely effective in recycling natural resources but also in more effective environment conservation.

Other advantages of green recycling are as follows:

(1) Contributions to the creation of recycling-based society

In May 2000, "Basic Law for Formulating the Zero-Waste Society" was enacted. The Law stipulates that generation of waste should be restrained and generated waste should be used as resources as much as possible. In the expressway business, in order to fulfill corporate responsibility, it is important that mowed grass and pruned branches be effectively utilized as resources, instead of discarding them as waste.

(2) Restrains to the re-emission of carbon dioxide into the atmosphere

In October 1998, "Act on Promotion of Global Warming Countermeasures" was promulgated to cope with global warming, and the efforts include reduction in greenhouse gases emissions, which is one of the causes of global warming. Trees absorb carbon dioxide through photosynthesis and accumulate the carbon dioxide inside to form their trunks and roots. Thus, if pruned branches or stumps are incinerated as waste, the accumulated carbon dioxide will be released. However, rapid release of carbon dioxide can be restrained by green recycling.

(3) Reduction of waste disposal cost

The revision of "Waste Disposal and Public Cleaning Law" made the disposal standard of waste strict, and the number of processing facilities is currently decreasing, and disposal costs is increasing. By effectively utilizing mowed grass and pruned branches as resources, instead of disposing of them as waste, the disposal cost can be reduced, and as a result, the operating cost of the expressway business can be reduced.

(4) Reduction of cost for purchase of green material

There are many zones along the expressway that are not suitable for planting because of compaction made by large heavy equipment, and thus soil needs to be improved or fertilizer needs to applied for planting. Also, mulches are used to protect plants from growth inhibition factors such as pressure from surrounding weeds. By using materials produced through green recycling for these necessary materials, the cost of the expressway business can be reduced.

(5) Reinforcement of planting maintenance work

Basically, expressway green space is roughly managed, except for customer-conscious rest areas, and interchanges. However, maintenance work for pruned branches is needed to ensure smoothness of traffic, harmony with the landscapes of the surrounding areas, and utilization of

characteristics of trees. By implementing such maintenance work effectively in the expressway business, green space can be maintained continually and properly.

5. PROMOTION OF GREEN RECYCLING

In NEXCO East Japan, the amount of mowed grass, pruned branches, and the like generated through the maintenance of the expressway exceeds 110,000 m^3 every year, and some 93% of the amount is recycled in response to the recent increase in environmental awareness. Particularly, in the Kanto Branch Office, which is in charge of constructing expressways (approx. 150 km) in the Kanto area (especially in Tokyo) as well as maintaining and operating the existing expressways (approx. 1,000 km), the amount of phytogenic material generated by the maintenance of the expressways reaches 50,000 m^3, and this is approximately 45% of the total amount of phytogenic material generated by the company as a whole per year. Some 98% of the amount is used to make compost and chips at four greening materials plants located in Itako (Ibaraki Prefecture), Sakura Tsuchiura (Ibaraki Prefecture), Nasu (Tochigi Prefecture), and Tomioka (Gunma Prefecture) (Table 1 and Fig. 4). These compost and chips are used as soil conditioner for trees in expressways under construction, vegetation base material for the afforestation of slopes, and means to prevent weeds from growing in planted areas.

In 1988, NEXCO East Japan started the investigation, examination, and experiment on techniques to make compost from phytogenic material, and the company has been producing compost since 1994. The following findings have been obtained from the assessment on other recycling situations, review on the compost production method, laboratory test results, trial operation at the green recycling plants, and the like.

Table 1. Plant operation results (2004 to 2008)

Unit: m^3

		2004	2005	2006	2007	2008
Material	Collected	21,503	39,594	42,091	52,172	63,271
	Processed	22,457	24,585*1	43,929	50,489	57,366
Compost	Produced	3,249	4,352	4,629	5,915	6,476
	Delivered	1,622	1,148	5,466	7,004	6,250
	Stock	2,522	5,060	3,250	1,898	1,958

*1: The amount processed at Tomioka in 2005 was not available and it was not calculated.

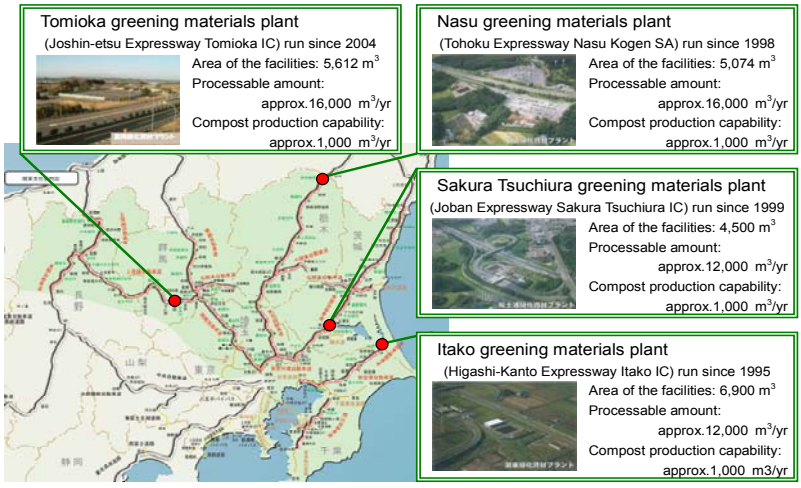

Figure 4. Plants in the Kanto Branch Office Area

(1) Mowed grass compost

The main raw material of the compost produced by NEXCO East Japan includes Japanese silver grass and Japanese blood grass that grow on the expressway slopes. While these materials are hard to decay, and thus there was concern that they were not suitable as materials to produce compost. As a result of investigation and experiments, it was

found that the above materials can be used to produce compost by “stacking the materials after cutting them” and “maintaining a certain amount of moisture.”

(2) Cutting machine

In order to accelerate fermentation and improve the efficiency of churning, mowed grass should be cut and then stacked. Since the thickness and the hardness of the stem and leaf of Japanese silver grass or Japanese blood grass differ depending on the season, it is necessary to establish a method for effectively cutting the grass with a single machine. Also, since a machine has to be able to cut woody plants, a shredder-type fine cutting machine was adopted.

(3) Acceleration of fermentation

Fermentation needs to be accelerated to uniformly ferment and decompose stacked mowed grass within a short time. However, it was found that, as a result of examination, fungi that help the acceleration of fermentation multiply while stacked and remain alive in compost or leach liquor in the fermenting tub. Thus, even if no fungi are used, by using the leach liquor for adjustment of moisture, good fermentation can be achieved.

(4) Production method

At all the four greening materials plants owned by the Kanto Branch Office, compost is produced outdoors through natural fermentation, and large scale, permanent, and mobile type facilities are used. Fig. 5 shows a schematic illustration of the procedure. The characteristics of this procedure are as follows:

1) Facilities are simple and require small capital investment.

Only a sufficiently spacious field is required, and the fermentation field simply requires pavement and drainage facilities to prevent leach liquor from flowing into the ground. Thus, only a small capital investment is required.

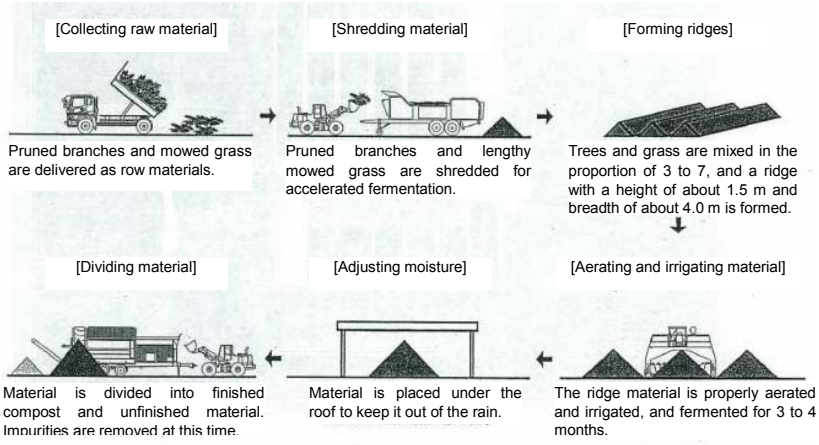

Figure 5. Outdoor, large-scale natural compost production method

2) A set of machines can be used for work at multiple plant facilities.

Since the processing capability of the compost manufacturing machine is large, time required for work in the plant is relatively short. Since the machine can be towed and used at multiple plants, working efficiency is high.

3) Processing of phytogenic material can be made suitable for the area.

The machine has large working capability, and thus a large amount of material can be processed if a spacious field is provided. However, since it takes about 3 to 4 months to produce compost, the processing amount per unit area is not large.

4) Effective utilization of leach liquor

The leach liquor generated during aeration and fermentation is collected by the gully and accumulated in the leach liquor tank. The leach liquor can be effectively utilized to adjust moisture during aeration and fermentation.

6. QUALITY OF HW COMPOST

The quality of compost made from phytogenic material generated from the expressway, as we called this compost “Highway compost (hereinafter referred to as HW compost)”, was compared with that of commercial ly available composts. Data concerning the commercially available composts used for comparison was obtained by recording the types, raw materials, prices, and components of the commercially available composts sold at green material mass retailers located near the four greening materials plants. These mass retailers sell various kinds of compost and fertilizer, but most of the composts include raw materials of livestock manure type (particularly cow manure). Table 2 shows the comparison results.

Comparison with the quality standards of the Japan Bark Compost Association revealed that, while most types of the HW compost meet the quality standards except for some produced by some greening materials plants that do not satisfy some of the standards, many types of the commercially available compost do not satisfy the standards (nitrogen, phosphoric acid, and potassium) except for C/N. Consequently, it is thought that the HW compost has the same or better quality even when compared with commercially available compost. Also, since the HW compost includes a large amount of nitrogen (for

Table 2. Comparison between HW compost and commercially

Classification	Name	Type	Raw Material	Principal component content					Unit price (yen/?)
				Nitrogen (N) (%)	Phosphoric acid (P) (%)	Potassium (K) (%)	C/N ratio	Moisture (%)	
HW compost	Itako	compost	mowed grass, pruned branches	2.7	0.623	1.5	12	54	
	Nasu	compost	mowed grass, pruned branches	2.7	0.63	2.0	13	55	
	Sakura Tsuchiura	compost	mowed grass, pruned branches	3.2	0.39	1.2	11	37	
	Tomioka	compost	mowed grass, pruned branches	2.2	0.44	1.1	16	54	
	Average of HW compost			***2.7***	***0.5***	***1.5***	***13***	***50***	
Commercially available compost	product 1	compost	tree bark	1.27	lt. 0.5	lt. 0.5	38	56	28
	product 2	compost	tree bark	1.2	lt. 0.5	lt. 0.5	35	60±5	26
	product 3	compost	tree bark	0.8	0.1	0.2	47		21
	product 4	compost	pruned branches and leaves	0.6	0.3	0.3	26.3		23
	product 5	compost	pruned branches	0.9	0.3	0.3	30		17
	product 6	compost	bark	0.5	0.32	0.36	16.4		10
	product 7	compost	tree bark	1.2	lt. 0.5	lt. 0.5	35	35±5	59
	product 8	compost	tree bark, chicken manure, pig manure	0.72	1.87	0.93	19.3		18
	product 9	compost	tree bark, woody waste, cow manure	0.96	lt. 0.5	lt. 0.5	15		17
	product 10	compost	tree bark, chicken manure	0.6	0.5	lt. 0.5	20		10
	product 11	compost	tree bark, egg shell, fermented chicken manure	0.7	lt. 0.5	lt. 0.5	35		15
	product 12	compost	tree bark, chicken manure	0.6	lt. 0.5	lt. 0.5	23		17
	product 13	compost	tree bark, chicken manure, pig manure	0.72	1.87	0.93	19.3		28
	product 14	compost	tree bark, cow manure	0.72	0.75	1.22			52
	product 15	compost	tree bark, plant oil cake	0.62	0.14	0.19	30.2	54.2	10
	product 16	compost	tree bark 95% to which microorganisms are added (VS-34)	0.6	0.3	0.3	25		79
	product 17	bark compost	bark, cow manure	0.59	0.34	0.37	27		20
	product 18	bark compost	bark, cow manure	0.59	0.34	0.37	27		12
	product 19	compost	bark compost (tree bark), cow manure compost (cow manure and sawdust)	0.4	0.6	0.5	23		20
	product 20	compost	tree bark and the like, cow manure	0.8	0.7	0.7	21	60	12
	product 21	compost	cow manure, bark, buckwheat husk, charcoal	2.6	1.4	1			26
	product 22	compost	cow manure, bark compost	1.3	0.6	1.8	22		16
	product 23	compost	cow manure, shredded bark, sawdust	1	1.6	1.8	26		10
	product 24	compost	cow manure, bark	0.83	0.82	1	26		16
	product 25	compost	cow manure, deciduous tree bark, sawdust	0.8	1.2	1.3			22
	product 26	compost	cow manure, bark	1.9	2.1	4.9	20.6	42.5	20
	product 27	compost	cow manure, sawdust, tree bark	1.2	1.63	2.42	23		20
	product 28	compost	sawdust, cow manure, tree bark	1.5	1.8	2.6	23		116
	Average of the products 1 to 28			***0.9***	***0.8***	***1.0***	***26***	***51***	***26***
Quality standards		Quality standards by NPO Japan Bark Compost Association		1.2 or greater	0.5 or greater	0.3 or greater	35 or greater	60±5	

1) Values in ( ) in the table indicate the product quality satisfying the quality standards of Japan Bark Compost Association.
2) The components of the HW compost are based on the results of the analysis conducted in 2005.
3) As to the average of the commercially available compost, the components of phosphoric acid and potassium were calculated based on their upper limits (“less than 0.5” was calculated as 0.5).

leaf growth) and potassium (for root growth), it is thought that, if used for vegetables, the compost is suitable for leaf vegetables such as spinach, cabbage, and Chinese chive and root vegetables such as daikon radish, carrot, and burdock.

7. STUDY ON MORE EFFECTIVE UTILIZATION OF GREEN RECYCLING

Currently, the HW compost produced by greening materials plants in the Kanto Branch Office area is being returned to the road as soil conditioner to be used in landscaping at construction work and as vegetation base material in slope afforestation work. However, since reduction of construction work is decreasing the demand for the compost with respect to the supply, an excess of compost is expected. Therefore, in the future, in addition to cost reduction and profit growth, effective utilization of the compost is necessary, including contribution to the local community.

7-1. Utilization of recycled material for expressway green belt

Since chip mulches inhibit the growth of weeds in grass fields and facilitate the management of the grass fields, chip munches should be actively implemented for maintenance. When crushed materials such as pruned branches are used as mulches for planting areas, it is necessary to ensure that the mulches include no weed seeds or no harmful components (such as phenols) to avoid no adverse effect on planted trees.

Mulches at garden road

Mulches at planting area

Figure 6. Examples of application of chip mulches

Fig. 6 shows examples of chip mulches. While mulches were applied to the garden road twoyears earlier, they are still as beneficial as when they were first applied. Similarly, while mulches were applied to the planting area three years earlier, no dispersal to the surrounding area was found and the growth of weeds was effectively controlled. At these locations, angled and frayed chips were seen immediately after the application, which caused concern about injury such as a fall. However, no injury has so far been reported and the mulches were moderately degraded when checked.

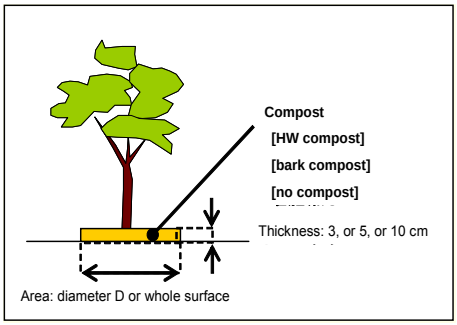

Figure 7. Example of soil improvement

7-2. Tree growth test

At an arboriculture field, a tree growth test was conducted by using compost with different areas,

thicknesses, and types to examine the effects of the compost. The effects were examined as follows:

(1) Three sections (HW compost section, bark compost section, and comparative section (no compost)) were set to determine the effects of HW compost.

(2) The tree height, root diameter, and physical and chemical characteristics of the soil were measured to examine the growth of the trees and change in soil component.

(3) The amount of HW compost applied was changed to examine the effective amount of the compost.

(4) The same test was conducted on 3 types of trees (zelkova serrata, aesculus turbinata, and prunus sargentii) and the results were compared for each of the types.

The results of the test were compared in terms of the area, thickness, and type of the applied compost. Five trees for each of the three types were planted in one section, and two sections were set for each type. A total of 16 sections were arranged to conduct the growth test.

(1) Area applied: diameter D (diameter of the hole in which the plant was planted), whole surface (width: 1.0 m)

(2) Thickness applied: 3 cm, 5 cm, and 10 cm

(3) Type: HW compost, bark compost (diameter D and thickness 5 cm alone), and comparative section (no compost)

The measured values (tree height and root diameter) obtained by the test conducted on the above sections in April 2007 were used as a benchmark (1.0), and compared with the measured values obtained by the second and third tests conducted in July 2007 and November 2007, respectively (Fig. 8). Trees that stopped growing and died from disease or pest were removed from the comparison. According to the results obtained by the third measurement, both in tree height and root diameter, the

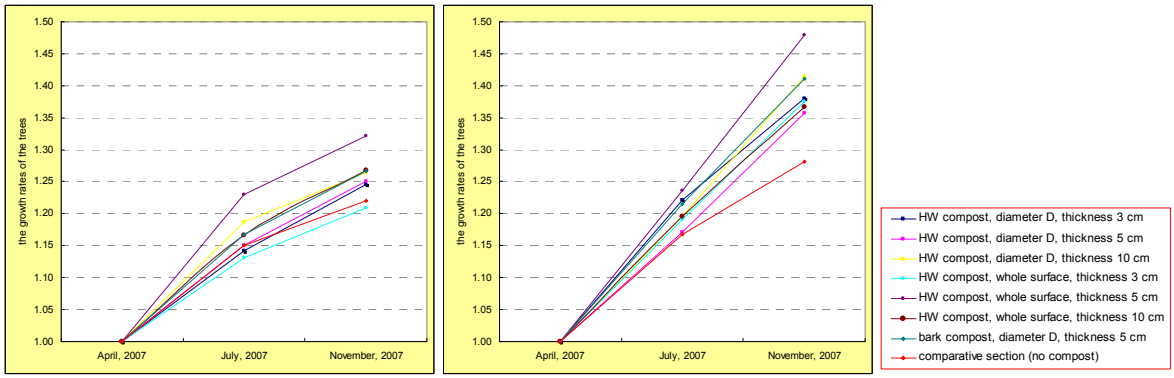

Figure 8. Tree growth rate relative to benchmark in April 2007 (left: height, right: root diameter)

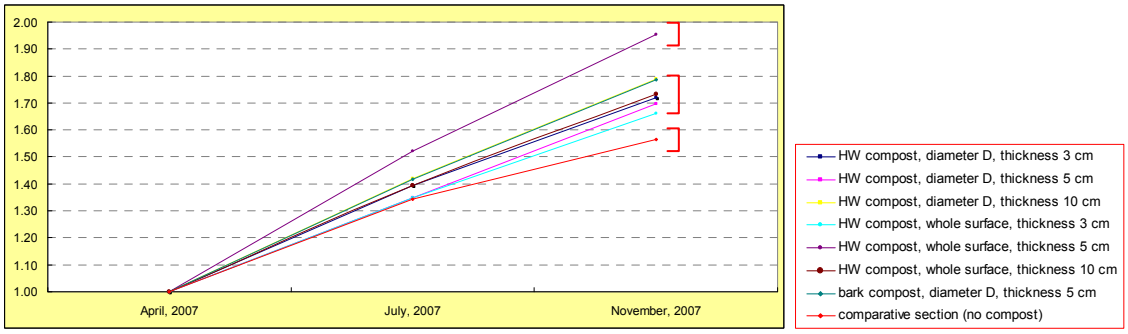

Figure 9. Tree growth rate relative to benchmark in April 2007 (height x root diameter)

growth of trees in the HW compost section (whole surface, thickness 5 cm) was greatest, followed by that of trees in the HW compost section (whole surface, thickness10 cm) and the bark compost section (diameter D, thickness 5 cm).

Also, the tree height was multiplied by the root diameter. As a result, it was found that, basically, the sections can be divided into three groups: HW compost section (whole surface, thickness 5 cm); other sections; and comparative section (Fig. 9). Thus, the following findings were obtained.

(1) There is a difference in growth between the compost sections and the comparative section, and it was found that the application of highway compost is effective.

(2) The growth rate of the trees in the HW compost section (whole surface, thickness 10 cm) is smaller than that of the trees in the HW compost section (whole surface, thickness 5 cm), and thus it is thought that the application of too much amount of compost has a negative effect.

(3) The growth rates of the trees in the highway compost sections (diameter D, thickness 3 cm), (diameter D, thickness 5 cm), and (whole surface, thickness 3 cm) were smaller than that of the tees in the highway compost section (whole surface, thickness 5 cm). Consequently, it is assumed that a smaller amount or area of applied compost results in poor growth.

Next, physical characteristics of soil components, such as hardness and permeability, were examined. Since a tree farm was used as the test site, soil hardness and permeability were originally good, and thus, clear effects of compost were not identified. However, tests were conducted on pH and electric conductivity, to examine chemical characteristics of soil, and the following results were obtained (Fig. 10):

(1) Regarding pH, all the agricultural fields were rather acidic.

(2) One year after compost was applied, all types of trees in the highway compost sections became more neutral.

(3) The electric conductivity was below 100 μs/cm before the application of compost, indicating insufficient amount of fertilizer. However, one year after compost was applied, the electric conductivity of all types of trees in the HW compost sections was improved.

(4) Regarding pH and electric conductivity, there was difference between the HW compost sections

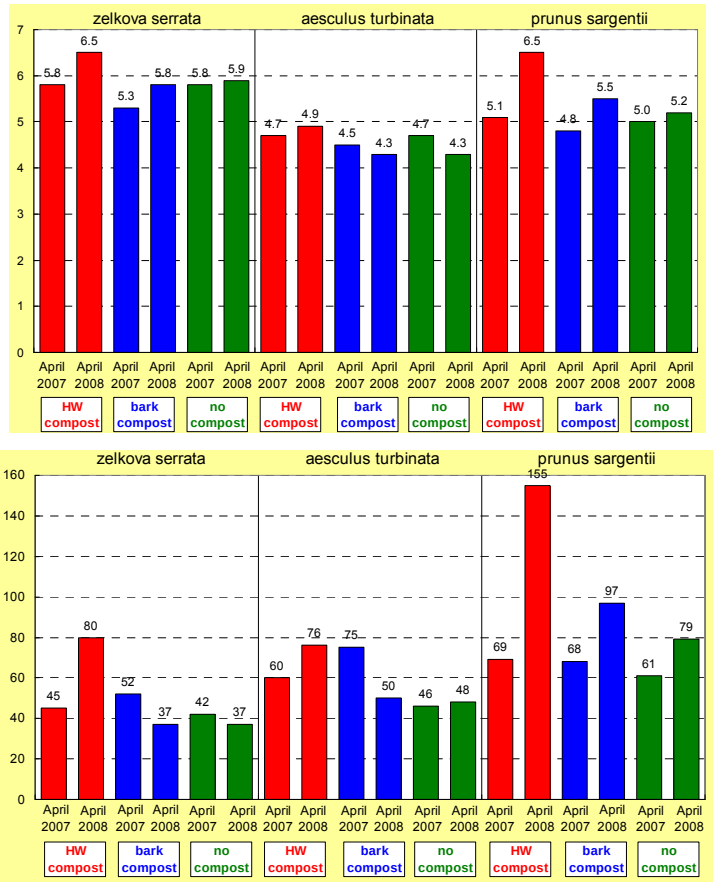

Figure 10. Chemical characteristics of soil
(top: pH, bottom: electric conductivity)

and the comparative section, and thus effectiveness of the compost was confirmed.

Consequently, the following findings were obtained.

(1) Application of highway compost indicates better growth, when compared with the comparative section (no compost).

(2) When the same amount is applied, application of bark compost indicates better growth. However, by changing the applied amount, equal or better growth can be expected than when the bark compost is applied.

(3) Application of highway compost changes soil property from acidic to neutral.

(4) Application of highway compost improves soil's fertilizer retention capacity.

7-3. Results of vegetable cultivation test

The various vegetable cultivation tests were conducted to see the effects of the HW compost. At Itako greening materials plant, cantaloupe was chosen for the cultivation test (conducted in 2008). HW compost was provided to nearby farmers, and comparison was made at harvest time between the growth of cantaloupes cultivated with the HW compost and those cultivated with fertilizer with horse manure that they usually use. As a result, as to the cantaloupes of size 2L or larger, which are generally available at supermarkets, the HW compost provided a greater number of cantaloupes, compared with the horse

Table 3. Results of cantaloupe cultivation test

		Application of HW compost							Application of conventional pig manure compost						
		boxes	per box	cantal oupes	rate (%)		unit price	price(yen)/total	boxes	per box	cantal oupes	rate		unit price	price(yen)/total
excellent	5L		3	0	0.0%		546	0		3	0	0.0%		546	0
	4L		4	0	0.0%		547	0		4	0	0.0%		547	0
	4L	57	2	114	10.2%		674	76,836		2	0	0.0%		674	0
	3L	5	5	25	2.2%		678	16,950	8	5	40	3.9%		678	27,120
	2L	1	6	6	0.4%	**12.9%**	669	4,014	7	6	42	3.9%	**7.8%**	669	28,098
	L		6	0	0.0%		566	0	1	6	6	0.5%		566	3,396
	M		6	0	0.0%		441	0	1	6	6	0.5%		441	2,646
	S		6	0	0.0%		304	0		6	0	0.0%		304	0
	2S			0	0.0%	**0.0%**		0			0	0.0%	**1.0%**		0
	subtotal	**63**		**145**	**12.9%**			**97,800**	**17**		**94**	**8.8%**			**61,260**
very good	5L	3	3	9	0.9%		494	4,446		3	0	0.0%		494	0
	4L		4	0	0.0%		500	0		4	0	0.0%		500	0
	4L		2	0	0.0%			0		2	0	0.0%			0
	3L	22	5	110	9.8%		589	64,790	24	5	120	11.8%		589	70,680
	2L	6	6	36	3.1%	**13.8%**	579	20,844	11	6	66	6.4%	**18.1%**	579	38,214
	L	2	6	12	0.9%		496	5,952	5	6	30	2.9%		496	14,880
	M	3	6	18	1.8%		369	6,642	6	6	36	3.4%		369	13,284
	S		6	0	0.0%		263	0		6	0	0.0%		263	0
	2S			0	0.0%	**2.7%**		0			0	0.0%	**6.4%**		0
	subtotal	**36**		**185**	**16.4%**			**102,674**	**46**		**252**	**24.5%**			**137,058**
good	5L	6	3	18	1.8%		395	7,110		3	0	0.0%		395	0
	4L	22	4	88	8.0%		449	39,512		4	0	0.0%		449	0
	4L		2	0	0.0%			0		2	0	0.0%			0
	3L	29	5	145	12.9%		460	66,700	23	5	115	11.3%		460	52,900
	2L	12	6	72	6.2%	**28.9%**	436	31,392	26	6	156	15.2%	**26.5%**	436	68,016
	L	3	6	18	1.8%		348	6,264	9	6	54	5.4%		348	18,792
	M	1	6	6	0.4%		252	1,512	8	6	48	4.9%		252	12,096
	S	1	6	6	0.4%		202	1,212	3	6	18	2.0%		202	3,636
	2S			0	0.0%	**2.7%**		0			0	0.0%	**12.3%**		0
	subtotal	**74**		**353**	**31.6%**			**153,702**	**69**		**391**	**38.7%**			**155,440**
satisfactory	5L	5	3	15	1.3%		289	4,335		3	0	0.0%		289	0
	4L	14	4	56	4.9%		304	17,024		4	0	0.0%		304	0
	4L		2	0	0.0%			0		2	0	0.0%			0
	3L	29	5	145	12.9%		331	47,995	7	5	35	3.4%		331	11,585
	2L	24	6	144	12.9%	**32.0%**	300	43,200	16	6	96	9.3%	**12.7%**	300	28,800
	L	7	6	42	3.6%		257	10,794	9	6	54	5.4%		257	13,878
	M	6	6	36	3.1%		200	7,200	10	6	60	5.9%		200	12,000
	S	1	6	6	0.4%		167	1,002	7	6	42	3.9%		167	7,014
	2S			0	0.0%	**7.1%**		0	3		0	0.0%	**15.2%**		0
	subtotal	**86**		**444**	**39.1%**			**131,550**	**52**		**287**	**27.9%**			**73,277**
total	5L	14	3	42	4.0%			15,891	0	3	0	0.0%			0
	4L	36	4	144	12.9%			56,536	0	4	0	0.0%			0
	4L	57	2	114	10.2%			76,836	0	2	0	0.0%			0
	3L	85	5	425	37.8%			196,435	62	5	310	30.4%			162,285
	2L	43	6	258	22.7%	**87.6%**		99,450	60	6	360	34.8%	**65.2%**		163,128
	L	12	6	72	6.2%			23,010	24	6	144	14.2%			50,946
	M	10	6	60	5.3%			15,354	25	6	150	14.7%			40,026
	S	2	6	12	0.9%			2,214	10	6	60	5.9%			10,650
	2S	0		0	0.0%	**12.4%**		0	3		0	0.0%	**34.8%**		0
	subtotal	**259**		**1127**	#####			**485,726**	**184**		**1024**	#####			**427,035**

* The prices are based on the market study on October 7, 2008.

Figure 11. Results of cantaloupe cultivation test using HW compost

manure fertilizer normally used by farmers. Also, no problems were identified in cultivation.

8. CONCLUSION

Planting plants at places such as expressway slopes and gardens improves the appearance in the landscape and safety, and in addition, it contributes to the environment conservation, which came into focus through recent issues such as global warming. NEXCO East Japan is expected to cultivate, maintain, and manage such planting work in an effective way. The company aims for the formation of the circulatory system based on the theme “What is caused from the road returns to the road and contributes to the nature growth,” and needs to return to the intended purpose of recycling phytogenic material generated from the maintenance of the green belt, instead of discarding it through incineration. Further, NEXCO East Japan needs to actively utilize compost and chips in its construction and maintenance work and restrain generation of phytogenic material for effective management.

However, it is thought that the demand for compost and chips will decrease in the future. Thus, it is necessary to explore effective methods for utilizing phytogenic material in the maintenance division in order to devise a systematic, efficient, and continual management of green material. This report presents an example of effective utilization of phytogenic material.

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